DOCUMENT RESUME

ED 062 030 88 RC 006 055

TITLE	Fort Benton Trades & Industry Curriculum Outline.
INSTITUTION	Fort Benton Public Schools, Mont.
SPONS AGENCY	Office of Education (DHEW), Washington, D.C. Projects to Advance Creativity in Education.
PUB DATE	71
NOTE	66p.
EDRS PRICE	MF-$0.65 HC-$3.29
DESCRIPTORS	Auto Mechanics (Occupation); Building Trades; *Curriculum Guides; *Educational Objectives; Electrical Occupations; High School Curriculum; Instructional Materials; Mechanical Skills; *Small Schools; *Trade and Industrial Education; *Vocational Education

ABSTRACT

The trades and industry curriculum for the Fort Benton school system was designed with funds under Title III of the Elementary and Secondary Education Act as part of the vocational technology curricula to develop skills and attitudes that will permit students to find satisfaction and success in their careers. The curriculum, designed for grades 10-12, includes 3 semesters of mechanical communication; 3 programs on machines and mechanics (small engine mechanics, machinist skills and trades, and automotive mechanics); 3 programs in construction trades (electrical theory and installation, plumbing trades and skills, and carpentry and building construction); and 3 courses in metal trades (sheet metal project design and construction, foundry skills and practices, and metal fabrication). Objectives and instructional resources are specified for each course. (JH)

ORT BENTON TRADES & INDUSTRY CURRICULUM OUTLINE

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FORT BENTON
ESEA TITLE III
project 71-1024
summer 1971

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FORT BENTON TRADES & INDUSTRY CURRICULUM OUTLINE

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PREFACE

The means by which a small rural school system might provide a continuing curriculum development process are limited fiscally in most areas of Montana. Through the acquisition of a federal grant under ESEA Title III, we in the Fort Benton System have been able to overcome this limitation to some degree. Found in the pages of this curriculum outline are the efforts of Fort Benton teachers and administrators as well as the efforts of personnel from seven other Montana schools.

In today's paper world we often measure success by the volume of the printed word. The efforts put forth by the people involved in this project in no way can be acknowledged simply through an observance of volume. The real success of the program appears in the regeneration of teaching philosophy, methodology and enthusiasm. These in most part will show in the benefits rendered the students in the years to come.

I am not only proud to have been a part of this project, but also thank all the people involved for their cooperation. Any success or benefits of the project are theirs.

Members of this project from the Fort Benton School System will be available for consultant service to any organization or school district with regard to the outline contained herein or any other part of the project.

William J. Hoppes
Superintendent of Schools

STATEMENT OF PHILOSOPHY

Our primary purpose is to create vocational technology curriculums in specific areas which will help each student develop into a constructive citizen. The student will have the opportunity to develop cooperative attitudes toward society, acquire values consistent with the democratic creed and obtain a dependable body of knowledge and technical skills. The Vo-Tech curriculums will assist in the development of those skills and attitudes which will permit students to find satisfaction and success in their careers.

We believe that in order to make our vocational technology curriculums more meaningful for our students a planned scope and sequence is necessary. In order to accomplish this the student will explore areas within the scope of vocational technology. These areas are Business Education, Home Economics, Agri-Industry, Trades and Industry, and Industrial Arts.

Through these vocational technology areas the student will have the opportunity to integrate into his life learning processes, self-expression, and skill development.

INTRODUCTION

This Trades and Industry Curriculum was developed primarily for the Fort Benton School System by a committee representing several Montana School Districts. The project was funded through an ESEA Title III grant to the Fort Benton Public Schools.

The writing of this outline involved a highly concentrated six-week effort on the part of each individual committeeman. The Trades and Industry Curriculum project personnel were:

James A. Longin	Fort Benton	Project Director
Robert Jerome	Fort Benton	Group Leader
Duane Taylor	Fort Benton	Consultant
Russ Axtman	Fort Benton	Student Consultant
Don Freshour	Shelby	
Sam Ohanesian	Shelby	

TERMINOLOGY

1. APPRENTICESHIP - serving a period of time to learn a trade by practical experience under the supervision of skilled workers.

2. BEHAVIORAL CONCEPT - refers to those concepts written in behavioral terms which are intended to further develop the grade level theme.

3. BEHAVIORAL INSTRUCTIONAL OBJECTIVE - refers to those objectives used to measure the terminal behavior of the student which are intended to help develop the behavioral concept and in turn the grade level theme.

4. BENDING STRESS - the resistance of a material to bend or change shape upon the application of weight or pressure.

5. BLUEPRINT - maps, mechanical drawings or architects' plans used to interpret a project.

6. CALKING - a compound used to stop up and make tight against leakage.

7. CASTING - to give shape to a substance by pouring in liquid into a mold and letting harden.

8. CIRCUITRY - the detailed plan and components of an electric circuit.

9. CODES - those rules and regulations governing the materials and craftsmanship, prescribed by qualified authorities familiar with the trade.

10. CONNECTORS - a device used to connect two or more electrical wires together.

11. CONTINUITY TESTER - an instrument used to test whether or not there is a continuous path where electrical current may pass.

12. CRAFTSMANSHIP - level of performance expected of a skilled workman in a trade.

13. DIFFERENTIATE - to recognize and state differences.

14. DEFINE - to establish or state clearly with authority.

15. DESIGN - the arrangement of elements that make up a work of art or other man-made object.

16. ELECTROMAGNET INDUCTION - a property of an electric circuit by which an electromotive force is induced in it by a variation of current.

17. ELECTROMOTIVE FORCE - something that moves or tends to move electricity.

18. EVENT - a specific happening.

19. FABRICATION - to construct or manufacture from parts.

20. FIT - the degree of closeness with which surfaces are brought together in an assembly of parts.

21. FIXTURE - an object that consumes electrical energy in its operation.

22. FRAMING - the structural skeleton designed to support a building.

23. FRICTION - resistance to relative motion between two bodies in contact with each other.

24. FUNCTIONAL - designed or developed chiefly from the useful point of view.

25. GAGE - a series of numbers used to determine metal thickness and wire sizes.

26. GOALS - refers to those thirteen basic goals established by this committee as the over-all concern of this curriculum.

27. GRADE LEVEL THEME - refers to that theme which is being developed at that particular grade level.

28. I.D. - abbreviation for inside diameter or inside measurement of a round object.

29. INDUCE - to cause the formation of.

30. JOINT - a place where two things or parts are joined.

31. LAYOUT - to plot the points which produce the dimensions of an object - often to actual size for use in cutting out the object.

32. LEADING - the process of using molten lead in sealing a joint in cast-iron pipe after calking with oakum.

33. MACHINE - (1) a device to do work; (2) to shape a piece of metal stock by mechanical means, such as a metal lathe.

34. MACHINING - the process of forming or shaping a piece of metal to the desired dimension.

35. MAJOR THEME - refers to that theme which is being developed throughout the entire curriculum, "the expanding social order".

36. MOLD - the hollowed form in which molten metal is poured to form a casting.

37. NOMENCLATURE - names given to the pieces which make up an object.

38. O.D. - abbreviation for outside diameter, used commonly in expressing pipe dimensions.

39. ORTHOGRAPHIC PROJECTION - projection of a single view of an object in which the view is projected along lines perpendicular to both the view and the drawing surface.

40. OVERHAUL - to repair completely all parts of the engine proper (e.g., crank shaft, bearings, rods, pistons, rings, cylinders, cam, valves, etc.) and not including fuel, cooling, electrical or other auxilliary systems.

41. PATTERN - an object of actual size which represents the product and when used in forming a mold, in foundry work, will produce the desired casting. May also be a two-dimensional drawing for use in sheet-metal work; see stretchout.

42. PERSPECTIVE - view of an object in pictorial form, giving impression of relative size and shape by using apparent size.

43. PLAN - (1) step-by-step organization of an operation so that no phase is overlooked; (2) used to describe a drawing of an object which is less detailed, generally, than a blueprint.

44. REDRESSING - returning to original state of condition, as in shaping a worn grinding wheel or a dull chisel edge.

45. SCAVENGING - the operation in a two-cycle engine where intake gases force out exhaust fumes in a single stroke.

46. SERVICE TECHNICIAN - an individual trained in those operations needed in normal maintenance of a machine.

47. SHEETMETAL - metal rolled into sheets of a thickness up to approximately 7/64 inch or 12 gauge.

48. SLEEVE - (1) a rolled tube of sheet metal held together by a seam, as a stove pipe; (2) a device designed to accept the tapered shank of a cutting tool on a machine lathe.

49. SPECIFICATIONS - those requirements which are established as a minimum for construction or in installation of systems in construction, usually established by designer or architect.

50. SPLICE - the union of two or more pieces of metal in electrical wiring.

51. STANDARDS - general levels of material and/or workmanship which are established by those responsible for maintaining structural quality.

52. STRETCHOUT - a pattern made of paper which can be folded to form the object as well as opened to show one piece construction.

53. STOPPAGE - an occurance which reduces or prevents the flow of liquid through a pipe.

54. SWEAT - the joining of two pieces of sheetmetal or tubing where solder has been placed between the parts to be joined. When solder is melted and cooled the joint is completed.

55. TOLERANCE - (1) the amount of variation in dimensions allowed in the construction of an object; (2) the clearance permitted between two surfaces coming close to each other.

56. TROUBLESHOOTING - a series of tests conducted to determine probable causes of malfunctions.

57. WELDER - a machine used in welding.

58. WELDOR - one whose work is welding.

BASIC GOALS

This project group identified thirteen basic goals in the field of Vo-Tech. These goals are stated as follows:

1. Develop an appreciation of vocational technology.
2. Develop an insight and understanding of employment opportunities.
3. Develop the ability and enthusiasm for continuous learning.
4. Develop basic skills in the proper and safe use of common tools, machines, and processes used in the vocational areas.
5. Develop desirable social relationships.
6. Develop the insight with which the student can become aware of his capabilities.
7. Develop marketable skills and vocational competence to meet the needs of the students.
8. Develop consumer attitude whereas students can select, buy, use, and maintain the products of industry more intelligently.
9. Develop technical skills that can be applicable to the student for personal use.
10. Develop an insight into the world of work and its place in our culture.
11. Develop the abilities and enthusiasm for creative expression involving the materials, the processes and the products of vocational technology.
12. Develop the abilities for problem solving.
13. Develop an understanding of industrial processes and the practical application of scientific principles.

THEMES AND THEIR RATIONALE

For grades ten through twelve a theme is identified and a rationale is indicated for that theme.

Theme	Rationale
Machines and Mechanics	
Small Engine Mechanics	In this age of machines, a basic understanding of mechanics is critical not only for those entering specialized mechanical trades but also for those who merely deal with machines randomly throughout life. For a student to become aware of the opportunities and have an insight into the field of mechanics, the small engine course provides a format. This orientation will provide a base for the decision to terminate or continue his study of mechanics.
Machinist Skills and Trades	Machinist skills are important to the mechanic who must fabricate a part or modify a machine for special purposes. It is critical to the background of a metal craftsman who creates and designs for a career or as a hobby. The knowledge, skills and attitudes relative to precision metal working are both satisfying and rewarding to those who choose to meet its challenge.
Automotive Mechanics	The student at this level has developed more maturity, basic skills and some work experience in the area of mechanics. This course will build on the foundation of small engine mechanics. In order to reach job entry level requirements in the field of automotive mechanics, students will be involved in a wide variety of supervised work experiences and will develop necessary skills and attitudes.
Construction Trades	
Electrical Theory and Installation	Inasmuch as electricity is the most common source of energy for the home and shop, an understanding of the theory and methods of making it available for use is sound preparation for many manually oriented persons. This information is critical to anyone entering the building trades.
Plumbing Trades and Skills	This course will provide practical knowledge and skills of the plumbing trade. It will pursue plumbing skills through their relation to building construction, to include building codes and regulations on installation and connections to home or municipal disposal systems. Although geared to construction, this course would be of practical use to every home dweller.
Carpentry and Building Construction	Construction, dealing primarily with wood products in building construction, is a practical approach to an introduction to the building trades. It will deal with the actual construction and develop an experiencal

	sequence. As well as career application, it will be valuable for any handyman.
Metal Trades	
Sheet Metal Project Design and Construction	Heating and ventilation system, fabricators of equipment as well as the hobbyist can easily find application for sheet metal skills. The designing of patterns, cutting, shaping and joining of sheet metals from simple projects to commercial prototypes will be accomplished. This course will be basic to entering the fabrication course in the T & I Curriculum.
Foundry Skills and Practices	As a skilled craftsman in the metal industry, foundry skills are fundamental to a broad knowledge of the field. Methods of constructing molds and forming castings will follow the orientation to foundry techniques and career opportunities.
Metal Fabrication	The proof is in the application of skills. Fabrication relates to the construction phase of metal working skills. It is to include practical application of the skills developed in welding, sheet metal training and machine shop. Project work, cooperative vocational experience and advanced skill training may be pursued within this course.
Primary Mechanical Communication	Primary Mechancical Communication is an introductory course designed to develop a basic understanding of the field. Through this understanding, students will be prepared to make choices as to continued work in the area of mechanical communication. Students will also acquire a useable and practical skill which is essential to basic trade and industrial courses and helpful in the everyday planning of construction projects.
Secondary Mechanical Communication	As a second course in mechanical communication, this course is designed for those students who have found an aptitude in this area and who wish to become more proficient in this skill. Skills will be extended to include blueprint interpretation and preparation for projects of building-unit size. Those who complete this course will have the necessary skills for developing complex patterns and construction details. Secondary Mechanical Communication will provide background for introductory post-secondary courses of a technical nature.
Advanced Mechanical Communication	In the advanced course students will become adept to the extent of making job entry a reasonable goal with minimal additional training after graduation. In areas of employment other than specific mechanical drawing trades, supplemental course work or on-job training would be expected. Specific skills and a lower tolerance for error will be emphasized during the advanced course.

GENERAL NOTES

I. The theme subject areas for the Fort Benton Trades and Industry Program are as follows:

A. Machines and Mechanics

1. Small Engine Mechanics - 18 weeks
2. Machinist Skills and Trades - 18 weeks
3. Automotive Mechanics - 36 weeks

B. Construction Trades

1. Electrical Theory and Installation - 9 weeks
2. Plumbing Skills and Trades - 9 weeks
3. Carpentry and Building Construction - 18 weeks

C. Metal Trades

1. Oxy-Acetylene and Arc Welding (Agri-Industry Curriculum) - 18 weeks
2. Sheet Metal Project Design and Construction - 18 weeks
3. Foundry Skills and Practices - 18 weeks
4. Metal Fabrication - 18 weeks

The suggested grade level placement and sequence is given below as a guide for completing a program of skill development. An ideal program for skill development in Automotive Mechanics would begin with Arc and Oxy-Acetylene Welding, then Small Engine Mechanics, Machinist Skills and Trades, and end with Automotive Mechanics. For a production welder or metal construction craftsman, begin with Arc and Oxy-Acetylene Welding, then Sheet Metal Project Design and Construction, Machinist Skills and Trades, Foundry Skills and Practices, and finally, Metal Fabrication.

Electrical Theory and Installation and Plumbing Skills and Trades appear ahead of Carpentry and Building Construction because these skills will become useful in the construction phase of the carpentry course. The construction of a building requires the simultaneous use of all three skill areas: electrical, plumbing, and carpentry. The three courses make up the complete construction trades area.

Although Oxy-Acetylene and Arc Welding are covered in the Agri-Industry Curriculum, these courses are critical to the development of the Trades and Industry Curriculum. Likewise, Small Engine Mechanics will be utilized by mechanics students in Agri-Industry. Sophomore students who are interested in a full T & I program should take their welding at that level. Welding is also available at the upper grade levels.

Sophomore:
Oxy-Acetylene Welding (Agri-Industry Curriculum)
Arc Welding (Agri-Industry Curriculum)
Mechanical Communication

Junior:
Small Engine Mechanics - 18 weeks
Sheet Metal Project Design and Construction - 18 weeks
Machinist Skills and Trades - 18 weeks
Oxy-Acetylene Welding (Agri-Industry Curriculum)
Arc Welding (Agri-Industry Curriculum)

Senior:
- Machinist Skills & Trades - 18 weeks
- Foundry Skills & Practices - 18 weeks
- Automotive Mechanics - 36 weeks
- Metal Fabrication - 18 weeks
- Plumbing Skills and Trades - 9 weeks
- Electrical Theory and Installation - 9 weeks
- Carpentry and Building Construction - 18 weeks

Prerequisites are recommended as follows:

For Automotive Mechanics -

- Small Engine Mechanics

For Metal Fabrication -

- Oxy-Acetylene Welding
- Arc Welding
- Sheet Metal Project Design and Construction
- (Machinist Skills and Trades if possible)

For Carpentry and Building Construction -

- Electrical Theory and Installation
- Plumbing Skills and Trades

Other desirable course sequences are recommended on the preceding page.

MECHANICAL COMMUNICATION

GRADE TEN

MECHANICAL COMMUNICATION

I. Develop an understanding of mechanical drafting as related to its definition and uses.

   A. The student will be able to relate the drawing to the finished product.
   B. The student will be able to relate mechanical communication with industry.

II. Develop skills and understanding of the use of drafting equipment.

   A. The student will be able to select and use the proper drafting equipment (e.g., drawing board, T-square, triangles 30^{o} - 60^{o}, and 45^{o}, drawing pencils, pencil pointers, erasing shield, pencil eraser, protractor, french curves, compass, dividers, and scales.).

III. Develop the understanding and ability to letter correctly.

   A. The student will be able to fasten paper to the drawing board, select the proper drawing pencils, sharpen a drawing pencil, measure with a scale rule, lay out a format, space and draw guide lines and erase pencil lines.
   B. The student will be able to letter single stroke, vertical upper and lower case letters.
   C. The student will be able to letter single stroke, inclined upper and lower case letters.

IV. Develop an understanding and ability of geometric construction.

   A. The student will be able to draw parallel and perpendicular lines to a given line.
   B. The student will be able to draw line and arc tangents.
   C. The student will be able to bisect lines, arcs, and angles.
   D. The student will be able to layout angles by construction and divide a line into a given number of parts.
   E. The student will be able to construct a triangle, regular hexagon, octagon, and ellipse.
   F. The student will be able to locate centers and draw circles and arcs.
   G. The student will be able to plot and draw a curve using a french curve.

V. Develop an understanding and ability of sketching.

   A. The student will be able to sketch in missing lines and views.
   B. The student will be able to draw orthographic, oblique, isometric, and perspective sketches.

VI. Develop the ability to make and interpret Orthographic projections.

   A. The student will be able to develop more skills with the alphabet of lines (e.g., center, extension, hidden, boarder, visible, etc.).
   B. The student will be able to plan spacing between views and location of views.
   C. The student will be able to supply missing views.
   D. The student will be able to show objects in their true length.
   E. The student will be able to letter top, front, and side on appropriate views.

F. The student will be able to dimension fully using dimension and extension lines, arrowheads, leaders, fractional and decimal dimensions.

VII. Develop the ability to make and interpret pictorial drawings.

A. The student will be able to plan the location of the drawing on paper.
B. The student will be able to draw isometric and oblique drawings from orthographic drawings.
C. The student will be able to make isometric drawings that involve circles, arcs, and irregular curves.
D. The student will be able to draw a perspective delineation or picture from Orthographic projections.
E. The student will be able to draw isometric drawings involving non-isometric lines.

VIII. Develop the ability to make and interpret section drawings.

A. The student will be able to draw all visible edges and contours behind the cutting plane.
B. The student will be able to draw section lines and cutting plane lines in appropriate views.
C. The student will be able to visualize and draw full, half, revolved, removed, offset, ribs in section, aligned and intersections in sections.
D. The student will be able to draw conventional breaks.

IX. Develop the ability to make and interpret auxiliary drawings.

A. The student will be able to draw auxiliary views using the folding line method.
B. The student will be able to draw auxiliary views using reference plane method.
C. The student will be able to draw the incline plane in its true size.

X. Develop the skill and understanding to visualize and construct models.

A. The student will be able to draw patterns.
B. The student will be able to construct freehand moldings.

XI. Develop the ability to make and interpret architectural drawings.

A. The student will be able to draw a floor plan.
B. The student will be able to draw three elevations.
C. The student will be able to draw construction details (e.g., footings, foundations, sills, wall framing, and roof framing.).
D. The student will be able to draw a wall section.
E. The student will be able to draw a perspective sketch.
F. The student will be able to locate furniture on a floor plan.
G. The student will be able to draw symbols for doors, windows, and building materials.
H. The student will be able to locate electrical and plumbing symbols on a floor plan.
I. The student will be able to draw cabinet, fireplace, and stairway details.

XII. Develop the skills and understanding of drawing reproduction.

A. The student will be able to make and trace a drawing.
B. The student will be able to ink a tracing.
C. The student will be able to duplicate drawings.

Example of Behavioral Instructional Objective:

Given a cube of plasticene clay and modeling tools, the student will construct from a drawing a model in true shape and size.

RESOURCES:

Books:

Mechanical Drafting - Hornung, William J., 1957
Mechanical Drafting and Related Technology - Yankee, Herbert W., 744 Yan, 1966
Mechanical Drawing Problems - Beng and Kronquist, 1946
Industrial Arts Drafting - Walker, John R. and Plevyak, Edward J., 1964
General Drafting - Blum, Robert E., 744 Blu, 1969
Drafting - Brown, Walter C., 1964
General Drafting - Frylund, Verne and Kepler, Frank, 1969
You Can Draw A Straight Line - Thompson, Ray, 1963
Creative Drafting - Earle, James H., 1970
Architectural Drawing - Elwood, Franklin George, 1935
Architecture: Drawing and Design - Hepler, Donald E., 1965, 720 Hep
Architectural Drafting - Bellis and Schmidt, 1961
Problems in Architectural Drawing - Elwood, Franklin George, 1935
Introduction to Applied Drawing - Hale, E. M. and Hill, Cary L., 1962
Blueprint Reading, Checking and Testing, Parts 1 & 2 - Steinike, Otto, 1956
Blueprint Reading and Sketching - Lightle, R. Paul, 1965
Electronics Drafting Workbook - Kirshner, Cyrus, 1966, 744 Kir
* Mechanical Drawing - Thomas E. French and Carl L. Svensen, McGraw-Hill
* Orthographic Projection Simplified - Charles Quinlan, Jr., McKnight & McKnight, 1969
* The World of Drafting - Stan Ross, McKnight & McKnight, 1971
* Creative Mechanical Drawing - Basic, Oval S. Harrison, American Technical Society
* Drafting: Basic Techniques - Marshall L. Mossman, Prakken Publications, Inc.
* Drawing & Planning for Industrial Arts - John L. Feirer, Bennett Books
* Beginning Mechanical Drawing - William Roberts, Bennett Books
* Drawing for Product Planning - George E. Stephenson, Bennett Books
* Learning to Read Mechanical Drawings - Roy A. Bartholomew, Francis S. Orr, Bennett Books, 1970

* Indicates that this material is not in the Fort Benton School System - however, purchase is recommended.

GRADE ELEVEN

SECONDARY MECHANICAL COMMUNICATION

I. Develop skill and understanding of pattern development and intersections.

A. The student will be able to draw plane, single curve surfaces and a warped surface (e.g., cylindraid, coniod, helicoik, hyperboloid, and hyperbolic paraboloid.).
B. The student will be able to lay out developments (e.g., prisms, cylinders, pyramids, and cones.
C. The student will be able to draw hems and joints for sheet metal.
D. The student will be able to find the intersection of planes and cylinders.
E. The student will be able to find the intersection of planes and prisms.
F. The student will be able to find the intersection of planes and pyramids.
G. The student will be able to find the intersection of planes and cones.
H. The student will be able to find the development of a hood and flue.

II. Develop skill and understanding of parallel line development.

A. The student will be able to draw line through a point and parallel to a line.
B. The student will be able to draw a line parallel to a line at a given distance.

III. Develop skill and understanding of triangulation.

A. The student will be able to divide surfaces into a number of triangles and transfer them to the development (e.g., development of an oblique cone by triangulation).

IV. Develop the skills to make and interpret construction details.

A. The student will be able to draw in more detail construction plans (e.g., foundation, footings, sills, wall framings, and roof framings).
B. The student will be able to draw machine parts (e.g., pipes, gears, screws, cams, bolts, and nuts).

V. Develop the ability to make and interpret house plans.

A. The student will be able to identify the different reproductive systems (e.g., automatic blueprint machine, diazo-moist prints, diazo-dry process, thermo-fax, verfax, mimeograph, hectrograph, xerograph, offset, photographic contact, photostats. etching and microfilms).

Example of Behavioral Instructional Objective:

The student will make a clear transparency of a drawing using the thermofax machine.

GRADE TWELVE

ADVANCED MECHANICAL COMMUNICATION

I. Develop the increased skill and understanding of mechanical communications by individual problems (e.g., structural plans, machine plans and specialized plans such as electricity, plumbing, and hydraulics or other specific areas of interest.

RESOURCES:

Books:

Architecture - Hepler and Wallach, 1965, 720 Hep
General Drafting - Fryklund & Kepler, 1969
Machine Drafting - Herbert Yankee, 1966, 744 Yan
Technical Drafting Problems (workbook) - 1967
Architectural Drafting - Bellis & Schmidt, 1961
Mechanical Drafting - William Hornung, 1957
Technical Drawing - Giesecke, Mitchell, Spencer & Hill, 1967
Creative Drafting I - James Earle, 1970
Electronic Drafting Workbook - Kirshner & Stone, 1966, 744 Kir
You Can Draw a Straight Line - Ray Thompson, 1963
Blueprint Reading for the Construction Trade - Bellis & Schmidt, 1968, 744.5 Bel

Filmstrips:

Architecture and Your Life, with guide, 720a
Nature, Man, and Architecture, with guide, 720b
Our Alabaster Cities, with guide, 720c
Shakespear's Theater, with guide, 725
First Course in Mechanical Drawing, 744
Sections Views, 744.4a
Auxiliary View & Related Construction, 744.4b
Dimensioning, Part I, 744.4c
Dimensioning, Part II, 744.4d
Orthographic Drawing, Part I, 744.4e
Orthographic Drawing, Part II, 744.4f
Intersections, with guide, 744.4g
Compasses and Bow Instruments, with guide, 744.4h
Freehand Lettering, with guide, 744.4j
Scales, with guide, 744.4k
Developments, with guide, 744.4l
Isometric Drawing, with guide, 744.4m

Movies:

Orthographic Projection, 744.4 Ort
Language of Drawing, 744.4 Lan

Transparencies:

Mechanical Drawing, 744.4 Mec

MACHINES AND MECHANICS

GRADE ELEVEN

SMALL ENGINE MECHANICS

I. Develop an appreciation for the history of the engine.

A. The student will be able to discuss the invention and early development of the engine.
B. The student will be able to compare the early engine to the techniques and materials used today in engine construction.

II. Develop an understanding of the opportunities, duties and responsibilities of a service technician.

A. The student will research and be able to discuss the current employment situation (e.g., wages, opportunities, etc.).
B. The student will be able to outline the duties of a service technician (e.g. keep records, service, repair, etc.).
C. The student will be able to discuss desirable personal characteristics of a good technician (e.g., meeting the public, cleanliness, etc.).

III. Develop appropriate attitudes toward safety.

A. The student will be able to discuss the need for safety.
B. The student will be able to outline the safety hazards in this type of shop work.
C. The student will be able to locate and operate the fire extinguisher.
D. The student will be able to specify what to do in case of an emergency or accident.
E. The student will be able to demonstrate his knowledge of safety by practicing safety habits at all times.

IV. Develop favorable habits concerning cleanliness and good workmanship.

A. The student will be able to apply clean work habits to work area, parts, and clothing.
B. The student will be able to recognize desirable workmanship and discuss the need for good workmanship.

V. Develop an understanding of engine classification.

A. The student will be able to define an engine.
B. The student will be able to discuss how and why engines are classified (e.g., 2- or 4-cycle fuel, cylinder arrangements, number of cylinders, etc.).
C. The student will be able to discuss and describe the five active forms of energy (e.g., heat, light, kinetic, electrical and chemical energy).
D. The student will be able to identify the properties of matter using correct terminology (e.g., mass, inertia, velocity, work, momentum, energy, power and force).
E. The student will be able to compute the amount of work done when given the force used and distance moved.

VI. Develop an understanding of the properties of combusion and how it is used in an engine.

A. The student will be able to differentiate between the internal and external combustion engine.

B. The student will be able to discuss and explain the three states of matter (e.g., solid, liquid, gas) and how the molecules are affected by heat and pressure.
C. The student will be able to distinguish between molecules, atoms, elements, compounds, and substances.
D. The student will be able to discuss the triangle of combustion (e.g., fuel, oxygen, and a kindling point).
E. The student will be able to explain chemical changes brought about by chemical processes as related to combustion.
F. The student will be able to recite the definition of friction.
G. The student will be able to discuss how an explosion is used to obtain useful power.

VII. Develop an understanding of the piston type engine and the accessory systems required.

A. The student will be able to discuss the different types of internal combusion engines.
B. The student will be able to explain the operation of the piston-type engine.
C. The student will be able to discuss and relate the sequences, activities and events taking place in an internal combustion engine and how each is accomplished (e.g., valve position during intake, compression, ignition, power and exhaustete).
D. The student will be able to list and explain the need for cooling, lubrication, fuel, ignition and exhaust systems.

VIII. Develop an understanding of the timing of the five events of the internal combustion engine (intake, compression, ignition, power and exhaust).

A. The student will be able to discuss the importance of proper timing of the events in an engine.
B. The student will be able to identify the different types of valve and valve operating mechanisms.
C. The student will be able to distinguish between the L, I, F & T head engine and be able to discuss the advantages and disadvantages of each.
D. The student will be able to discuss how and why firing orders are determined.

IX. Develop an understanding of engine specifications and refinements.

A. The student will be able to indicate why engines are designed and constructed differently to accomplish scavenging, cooling and cleaning (carbon removal).
B. The student will be able to demonstrate his familiarity with different materials used in engine construction by being able to give advantages and disadvantages of each type.
C. The student will be able to list and define the engine parts and assemblies.
D. The student will be able to compute the compression ratio and displacement for engines and discuss the terminology.
E. The student will be able to list and explain the function, design and materials used in piston and connecting rod assemblies.
F. The student will be able to explain the use of seals and gaskets and the materials used in each.
G. The student will be able to discuss crankshafts, bushings, and bearings.

H. The student will be able to discuss and explain gears, sprockets and chains, their ratios, parts, types, kinds and how they can be used to advantage with the engine.
I. The student will be able to explain and list the types of tolerances and fits.
J. The student will be able to compute torque, locate specifications and use the torque wrench.

X. Develop an understanding of intake, fuel, and fuel systems.

A. The student will be able to discuss fuels, how they are classified, and their processing.
B. The student will be able to explain the properties of gasoline.
C. The student will be able to specify fuel-air mixtures and how it affects combustion.
D. The student will be able to list and explain the parts and systems of fuel delivery (e.g., tank, gauge, lines, pump, filter, and carburator, etc.).

XI. Develop an understanding of basic electricity and magnetism.

A. The student will be able to discuss the theory of electricity and magnetism.
B. The student will be able to define common terms used in electricity and magnetism (e.g., electrons, lines of force. A.C., D.C., coil, battery, electromagnets, etc.).
C. The student will be able to differentiate between the generator-battery and the magnet system.
D. The student will be able to explain the operation of the electrical parts used in the charging system (e.g., field, armature, cutout relay, battery, voltage, regulator, etc.).
E. The student will be able to discuss and trace a typical electrical charging system wiring diagram.
F. The student will be able to describe different types of generator systems.
G. The student will be able to disassemble, test, repair, reassemble, replace and polarize a generator.

XII. Develop an understanding of engine ignition systems.

A. The student will be able to reproduce a typical ignition wiring diagram.
B. The student will be able to list and explain the parts of the total ignition system.
C. The student will be able to test, diagnose, repair, adjust, and replace each part of the ignition system.

XIII. Develop an understanding of the uses and care of tools and equipment.

A. The student will be able to demonstrate a familiarity of all tools and equipment used in small engine mechanics.
B. The student will be able to maintain and store all of the necessary tools properly.

XIV. Develop an understanding of the exhaust, lubricating and cooling systems.

A. The student will be able to explain the theory, operations, function and terminology of exhaust, lubricating and cooling systems.
B. The student will be able to discuss the different types of lubrication, cooling and exhaust systems (e.g., splash, pressure, water, air, etc.).

C. The student will be able to discuss the grade, classification and application of motor oils and greases.
D. The student will be able to service and maintain lubrication systems.
E. The student will be able to service and maintain cooling systems.

XV. Develop an understanding of the types and operation of starting systems.

A. The student will be able to discuss the necessity of a starter.
B. The student will be able to discuss, service, adjust and maintain manual, mechanical and electrical starters.

XVI. Develop an understanding of power transmissions.

A. Each student will be able to discuss and define mechanical and velocity advantage and show their relationship.
B. The student will be able to discuss, repair and adjust the clutches used with small engines.
C. The student will be able to diagram and discuss ways of using gears, sprockets, and pulleys to change direction or mechanical advantage.
D. The student will be able to define friction and discuss its uses.
E. The student will be able to discuss, service, and repair the transmission, drive line and differential most commonly used with small engines.

XVII. Develop an understanding of troubleshooting and service techniques.

A. The student will be able to list the steps required to trouble shoot and service the total machine.

XVIII. Develop an understanding of care and maintenance of small engines and related machinery.

A. The student will be able to list and discuss items of care and maintenance on the complete machine.
B. The student will be able to properly prepare the machine for transfer or storage.

Example of Behavioral Instructional Objective:

Students will be able to list in the order that they occur and explain each of the four events to complete a cycle in a four-stroke engine with at least ninety percent accuracy.

RESOURCES:

Books:

Texts: Small Gasoline Engines - Delmar Publishers, 1964, Albany, N.Y.
Small Gasoline Engines: Training Manual - Howard W. Sams & Co., 1970, Indianapolis, Indiana 46206

Sample Texts: Technical Information on Engines - Kohler Co.
Briggs & Stratton Repair Instructions - Briggs & Stratton Co.
Briggs & Stratton Parts and Service Data - Briggs & Stratton
Clinton Engines Service Manual - Serial Number 51522, Clinton Engine Co.

Small Gasoline Engines Training Manual - Ted Pipe, 1970, Howard W. Soms & Co.

Small Gasoline Engines - George E. Stephenson, Delmar Publishers, Albany, N.Y., 1964
All About Small Gas Engines - Jud Purvis, Goodheart-Wilcox Co., 1963
Power Mechanics - Pat H. Atteberry
Power Technology - George E. Stephenson
Small Engines Care, Operation and Repair - AAAE & VA

GRADES ELEVEN AND TWELVE

MACHINIST SKILLS AND TRADES

I. Develop an appreciation for the history of machining.

A. The student will be able to discuss the development and advances in technology of machining.
B. The student will be able to discuss the importance of machining.

II. Develop an insight into the machinist's career opportunities.

A. The student will be able to discuss the current local employment situation.
B. The student will be able to list areas where technicians are needed.
C. The student will be able to complete an application for a machinist's position.
D. The student will be able to discuss occupational requirements necessary to a machinist.
E. The student will be able to discuss the duties of a machinist.

III. Develop required attitudes toward safety.

A. Each student will be able to discuss the need for safety.
B. Each student will be able to list hazardous areas and precautions to be taken.
C. Each student will be able to locate and operate all of the fire extinguishers and be able to turn in the alarm.
D. The student will be able to specify what to do in case of an emergency or accident.
E. The student will be able to demonstrate his knowledge of safety by practicing safety at all times.

IV. Develop favorable habits concerning cleanliness and good woarkmanship.

A. The student will be able to demonstrate clean work habits in the work area, parts and clothing.
B. The student will be able to differentiate between a completed and an incompleted project.

V. Develop an understanding for the proper names, use, care and maintenance of tools.

A. The student will be able to select and use the proper tool for a given operation.
B. The student will be able to explain where and how tools should be handled and stored.
C. The student will be able to demonstrate skills in redressing tools such as punches, drill bits, lathe bits, etc.
D. The student will be able to maintain, clean and lubricate the machines.
E. The student will be able to properly identify the tools.

VI. Develop an understanding of lubricants and oils used in machines.

A. The student will be able to specify which lubricant, if any, will be used when drilling, turning, or threading any of the materials he will be using.
B. The student will be able to list lubrication points and frequency on each machine to properly maintain it.

VII. Develop an understanding of drills and drilling.

A. The student will be able to discuss why tools are designed differently to cut different materials.
B. The student will be able to explain how each kind of drill bit is designed to cut and the application of each (e.g., twist, straight fluted, 3 lip, 4 lip, etc.).
C. The student will be able to discuss the parts of the drill bit and why each part is designed to perform a specific job.
D. The student will be able to sharpen a drill bit using the proper techniques and procedures.
E. The student will be able to bore a hole of predetermined size and location using proper techniques and procedures.
F. The student will be able to discuss ways of holding the twist drill in the drill press (e.g., chuck, morse taper, jorno taper, tapered sleeve).

VIII. Develop an understanding of layout and plan procedures.

A. The student will be able to read a simple plan and blueprint.
B. The student will be able to plan time and materials for each assignment.
C. The student will be able to layout his project utilizing proper methods and procedures.
D. The student will be able to identify the use of tools, and materials, used in layout (e.g., copper sulfate, prick punch, dividers, scribe, scale, etc.).

IX. Develop an understanding of measuring tools.

A. The student will be able to compute decimal equivalents.
B. The student will be able to measure using the machinist scale.
C. The student will be able to identify and adjust the parts of the micrometer.
D. The student wi-l be able to measure using each kind of micrometer and vernier caliper.
E. The student will be able to list other tools used in machine work and explain their uses (e.g., divider, caliper, hermaphrodite caliper, dial indicator, square, etc.).
F. The student will be able to discuss tolerance allowance and interference.
G. The student will be able to convert English measure to metric measure.

X. Develop an understanding of filing.

A. The student will be able to name the parts of, kinds, and cuts of files.
B. The student will be able to select and use the proper file as applicable to a specific operation.
C. The student will be able to discuss safety precautions when using a file.

XI. Develop an understanding of grinders, grinding wheels, and abrasives.

A. The student will be able to discuss abrasives, grinding wheels, and uses in machine processes.
B. The student will be able to safely operate the grinder.
C. The student will be able to redress a grinding wheel.

XII. Develop an understanding of taps, dies, reamers and the applications of each.

A. The student will be able to discuss uses of taps, dies, and reamers.

B. The student will be able to label the parts of the taps, dies, reamers and related equipment.
C. The student will be able to select and use the proper tap, die, or reamer to perform a preassigned task.
D. The student will be able to determine threads using the screw pitch gauge.
E. The student will be able to properly store, maintain and keep the tap, die and reamer.

XIII. Develop an understanding of metals.

A. The student will be able to discuss metals, the origin of metal and the processes involved in making it useable.
B. The student will be able to determine by chipping, spark or visually types of metal.

XIV. Develop an understanding of the lathe and lathe operations.

A. The student will be able to discuss the occupational possibilities for lathe operations.
B. The student will be able to name, label and list the function of the parts of the lathe.
C. The student will be able to discuss the operation of the lathe.
D. The student will be able to clean and lubricate the lathe.
E. The student will be able to define lathe terms.
F. The student will be able to chuck up and center a project using the universal 3 jaw and 4 jaw independent chuck.
G. The student will be able to set up work for turning between centers.
H. The student will be able to identify common lathe cutting tools.
I. The student will be able to identify and select the proper tool and tool holder.
J. The student will be able to set and use the cutting or knurling tool.
K. The student will be able to centerdrill on the lathe.
L. The student will be able to cut tapers on the lathe using the taper attachment, set over tailstock, and compound rest methods.
M. The student will be able to drill, bore and ream using the lathe.
N. The student will be able to set up and turn using the steady rest or follower rest.
O. The student will be able to set up and cut threads on the lathe.

XV. Develop an understanding of total machinery processes.

A. The student will be able to perform operations in the machinists area according to his interests and abilities.
B. The student will be able to operate other equipment under instructors supervision when it becomes available.

XVI. Develop an understanding of screw threads.

A. The student will be able to name and sketch the different types of threads and their uses.
B. The student will be able to label the parts of the thread.
C. The student will be able to discuss thread pits.
D. The student will be able to use proper nomenclautre when discussing threads (e.g., lead, pitch, diameter, root diameter, etc.).
E. The student will be able to select the proper size tap drill for a specified size tap and thread using the chart provided.

XVII. Develop the ability to set up and properly perform operations on the lathe such as turning, facing, finishing, threading, knurling, cutting off and boring.

Example of Behavioral Instructional Objective:

Each student will, with the guidance of the instructor, select and construct a simple project. The machined portions of the project will be within a tolerance of ± .002 of an inch for 80% of the projects completed.

RESOURCES:

Books:

Texts: Machine Tool and Metalwork - McGraw-Hill, Inc.
* Metalwork: Technology and Practice - McKnight & McKnight, Towarda Ave. and Route 66, Bloomington, Ill. 61701

Sample Texts: * Technical Metals - Charles A. Bennett Co., Inc., Peoria, Ill. 61614, 1968
* The Care and Operation of a Lathe - Sheldon Machine Co., Inc., Chicago
* How to Run a Lathe - Southbend Lathe, Inc., South Bend, Ind.

* Machinery's Handbook - 19th Edition, Industrial press, Inc.
* Modern Machine Shop Training - National Schools, Los Angeles
* Shop Mathematics - The Bruce Publishing Co., Milwaukee, Wisconsin, 1965
Study Prints & Charts: Machinist Trades, Dept. of Defense Materials, N.W. Regional Educ. Lab., Portland, Oregon

* Indicates that this material is not in the Fort Benton School Systems -however, purchase is recommended.

GRADE TWELVE

AUTOMOTIVE MECHANICS

I. Develop an appreciation for the history of the engine.

A. The student will be able to discuss the history and development of the engine.
B. The student will be able to relate the advances and improvements in the automobile engine and in the automotive industry.

II. Develop an insight into the current employment situation of automotive mechanics.

A. The student will be able to discuss the current local employment situation.
B. The student will be able to list areas where technicians are needed.

III. Develop an understanding of the requirements necessary to be proficient in any selected occupation in the automotive field.

A. The student will be able to list the employment positions one can achieve after successful completion of this course.
B. The student will be able to explain the degree of education needed to enter a chosen automotive occupation.

IV. Develop an understanding of the duties and desirable personal characteristics necessary to qualify as a trained automotive technician.

A. The student will be able to discuss the general duties applicable to the automotive technician.
B. The student will be able to discuss what personal characteristics are desirable and which are undesirable in the field of the automotive technician.

V. Develop required attitudes toward safety.

A. The student will be able to discuss the need for safety.
B. The student will be able to list the hazardous areas and precautions to be taken in the shop.
C. The student will be able to locate and operate all of the fire extinguishers and be able to turn in the alarm.
D. The student will be able to specify procedures in case of an emergency or accident.
E. The student will be able to demonstrate his knowledge of safety by practicing good safety at all times.

VI. Develop favorable habits concerning cleanliness and good workmanship.

A. The student will be able to apply clean work habits in the work area, parts and clothing.
B. The student will be able to discuss what one can call a completed project and evaluate the project.

VII. Develop an understanding of the proper names, use, care and maintenance of tools.

A. The student will be able to select and use the proper tool for a given job.

B. The student will be able to discuss where and how tools should be stored.
C. The student will be able to demonstrate by performance skills in redressing punches, chisels, screw drivers, drill bits, etc.
D. The student will be able to maintain, clean and/or lubricate any of the tools critical to this trade.
E. The student will be able to properly name the tools as he becomes familiar with each one.

VIII. Develop an understanding of the basic principle of the internal combustion engine.

A. The student will be able to compare and discuss internal and external combustion engines.
B. The student will be able to list and explain the four strokes and their function in a four cycle engine.
C. The student will be able to list and explain the function of the major components in the engine (e.g., crankshaft, piston, valve, etc.)
D. The student will be able to discuss the basic principles of engine operation (e.g., how is vacuum created in the engine).
E. The student will be able to discuss and relate the sequence, activities and events taking place in an internal combustion engine and how each event is accomplished (e.g., valve position during various piston strokes).

IX. Develop an understanding of the automotive cooling system.

A. The student will be able to list the parts of and discuss the operation and function of the automobile cooling system.
B. The student will be able to test and diagnose parts of the cooling system.
C. The student will be able to service and repair malfunctions in the cooling system.
D. The student will be able to explain, test, service and repair the heating system and discuss its relationship to the cooling system.

X. Develop an understanding of the engine lubricating system.

A. The student will be able to discuss the importance of an effective lubrication system.
B. The student will be able to list and discuss the parts in the lubrication system.
C. The student will be able to test and diagnose the engine lubricating system.
D. The student will be able to list and explain the different types of lubrication systems.
E. The student will be able to discuss properties, classifications, and applications of lubricants.
F. The student will be able to discuss repairs or corrections for problems located in the lubrication system.

XI. Develop an understanding of the precision instruments required by the automotive technician.

A. The student will be able to identify the instruments used by service technicians.
B. The student will be able to read, use and maintain all micrometers.
C. The student will be able to identify the proper measuring instrument for each application.

XII. Develop an understanding of the manuals and specifications for the automobile.

A. The student will be able to locate the information desired from the appropriate source.
B. The student will be able to compute engine specifications (e.g., displacement, compression ration, and horse power, etc.).
C. The student will be able to discuss terminology and nomenclature identified with automotive specifications.

XIII. Develop an understanding of the engine valve train and cylinder head.

A. The student will be able to list and explain the function of all the parts of the various valve mechanisms.
B. The student will be able to discuss the relationship between the valve operation and the total engine operation.
C. The student will be able to demonstrate his ability to do a complete valve job including the use of all necessary tools and equipment.
D. The student will be able to diagnose and repair malfunctions in the complete valve mechanism (e.g., replace valve guides, ream guides, clean hydraulic lifter, put in hard seat insert, adjust valve clearance, etc.).

XIV. Develop an understanding of the basic engine block.

A. The student will be able to discuss processes and materials used in the manufacture of the engine block.
B. The student will be able to clean and inspect the block to determine what will be required to repair it.
C. The student will be able to discuss the reboring and reconditioning of the complete engine block.

XV. Develop an understanding of the piston, crankshaft and connecting rod assembly.

A. The student will be able to identify and discuss the function of the piston, crankshaft and connecting rod.
B. The student will be able to check, inspect, and re-ring the piston.
C. The student will be able to discuss the fitting of the piston pin in a piston and/or connecting rod.
D. The student will be able to remove and inspect the crankshaft, fit the bearings and replace it properly.
E. The student will be able to install a piston and a rod assembly and connect it properly.

XVI. Develop the ability to perform an engine overhaul.

A. The student will be able to disassemble, repair and reassemble a complete engine.

XVII. Develop an understanding of the automobile fuel system.

A. The student will be able to identify all parts relative to the fuel system, and discuss the function of each.
B. The student will be able to explain different types of fuel gauges and discuss testing procedures on each.
C. The student will be able to discuss repairs of fuel tanks and the precautions that should be taken.

D. The student will be able to identify and test types of fuel pumps and replace malfunctioning pumps.
E. The student will be able to explain the operation of each circuit in the carburetor.
F. The student will be able to diagnose, service, repair and adjust the carburetor.
G. The student will be able to identify and service all types of air cleaners.

XVIII. Develop an understanding of engine fuels.

A. The student will be able to discuss fuels, how they are classified, their origin and the processes involved in the manufacture.
B. The student will be able to explain the properties of gasoline.
C. The student will be able to list other fuels used commonly in internal combustion engines (e.g., diesel, L.P.G.).
D. The student will be able to specify fuel/air ratios and how they affect combustion.

XIX. Develop an understanding of the fundamentals of electricity and magnetism.

A. The student will be able to discuss magnetism, magnetic fields, electromagnets, solenoids, relays and the relationship to their use in the modern automobile.
B. The student will be able to define common terms used when discussing electricity and magnetism.
C. The student will be able to explain and apply Com's Law.
D. The student will be able to operate electrical measuring instruments necessary for testing (e.g., voltmeter, ampmeter, continuity tester.).
E. The student will be able to trace and explain electrical wiring circuits.
F. The student will be able to discuss electromagnetic induction.
G. The student will be able to locate and interpret information and specifications applicable to electrical systems.

XX. Develop an understanding of the automotive electrical system.

A. The student will be able to safely service, test and discuss the storage battery.
B. The student will be able to identify types of circuits and locate them in the automobile.
C. The student will be able to test, and repair, automotive electrical circuits.
D. The student will be able to solder and use cold type connectors.
E. The student will be able to install, replace and adjust components necessary for the repair of electrical systems.
F. The student will be able to discuss the operation of other accessory units such as heater motor, courtesy lights, cigar lighter, etc.

XXI. Develop an understanding of cranking motors and charging systems.

A. The student will describe the function of the starter motor, control circuits, solenoid, switch, drive clutches and parts relative to each.
B. The student will be able to test, diagnose, repair and replace the starter motor and relative parts according to proper procedures.
C. The student will be able to describe and test the operation of the types of charging systems, controlling circuits, ammeter and parts relative to each.

D. The student will be able to define, test and adjust each part of the charging regulator.

XXII. Develop an understanding of the automobile ignition system.

A. The student will be able to diagram and label the component parts of an ignition system.
B. The student will be able to differentiate between the primary and secondary sections of the ignition system and explain the theory and function of each part.
C. The student will be able to remove, test, repair, adjust and replace the distributor accurately.
D. The student will be able to discuss and use ignition testing equipment and tools.

XXIII. Develop an understanding and appreciation of air pollution control.

A. The student will be able to list the sources of smog problems in the engine.
B. The student will be able to discuss and explain the function of the smog control systems.
C. The student should be able to service smog control systems.

XXV. Develop an understanding of standard transmissions.

A. The student will be able to explain the fundamentals of gears and gearing.
B. The student will be able to discuss procedures for the disassembly, repair and reassembly of the standard transmission.

XXVI. Develop an understanding of the automatic transmission.

A. The student will be able to explain the function of the torque converter.
B. The student will be able to follow service procedures as outlined in the service manuals.
C. The student will be able to apply his understanding of gearing to the automatic transmission.
D. The student will be able to identify major components in the automatic transmission and explain the operation of these parts.

XXVII. Develop an understanding of the drive mechanism.

A. The student will be able to identify types of drive lines.
B. The student will be able to discuss the design theory of the drive mechanism.
C. The student will be able to replace a universal joint properly.
D. The student will be able to explain the operation of standard and limited slip differential.
E. The student will be able to label the parts of the differential.
F. The student will be able to discuss the proper procedures for making repairs on the differential.
G. The student will be able to replace rear axle bearings.
H. The student will be able to identify different types of rear axle assemblies (e.g., full floating, etc.).

XXVIII. Develop an understanding of front axles and steering in the automobile.

A. The student will be able to label parts of the steering system.
B. The student will be able to describe and define parellelogram steering.
C. The student will be able to list and discuss critical points in the steering system that should be inspected frequently.
D. The student will be able to inspect, diagnose, and replace any parts in the steering system.
E. The student will be able to discuss front end geometry.
F. The student will be able to define and discuss caster, comber and toe-in and will demonstrate proper procedures for correcting each of these.
G. The student will be able to discuss and describe probable causes and consequences of mis-aligned front end.
H. The student will be able to discuss and explain aspects of wheel balancing (e.g., static and synamic).

XXIX. Develop an understanding of frame and wheel suspension.

A. The student will be able to discuss the theory of suspension systems.
B. The student will be able to discuss the operation and function of shock absorbers.
C. The student will be able to repair or replace using proper procedures any parts in the wheel suspensions system.

XXX. Develop an understanding of brakes and brake systems.

A. The student will be able to state Pascal's Law of Hydraulics.
B. The student will be able to label parts of wheel and brake assemblies.
C. The student will be able to explain how the energy of mass in motion is converted to energy in the form of heat.
D. The student will be able to explain the operation and construction of automobile brake systems.
E. The student will be able to properly adjust automobile brakes as outlines in the service manual.
F. The student will be able to disassemble, repair and reassemble any part of the brake system.
G. The student will be able to bleed the air from a sealed hydraulic pressure system.
H. The student will be able to discuss why brake work requires a very high degree of accuracy.

XXXI. Develop an understanding of automibile wheels and tires.

A. The student will be able to describe the difference between tire classifications.
B. The student will be able to differentiate between a tubeless and a tube-type tire.
C. The student will be able to discuss the differences in tire construction (e.g., 2 ply, 4 ply, etc.).
D. The student will be able to remove, repair and replace tires according to proper procedures.

Example of Behavioral Instructional Objective:

Students will differentiate between internal and external combustion engines with at least 90% of the class able to describe the energy transmission from its source through the drive mechanism of the engine (VIII.A).

RESOURCES:

Books:

Text: Automechanics - Charles A. Bennett Co, Inc., Peoria, Ill. 61614
(with Automechanics Workbook)

Sample Texts:
* Automotive Encyclopedia - Goodheart-Wilcox Co., 1968
* Auto Mechanics - Goodheart-Wilcox Co., 1963
* Automotive Mechanics, 5th Edition - Webster Division, McGraw-Hill Book Co., 1965

* Service Training Course - Ford Motor Co.
* Automotive Diagnosis and Tune-Up - Master Technical Press, Park Ridge, Ill., 1959
* Suntester Bulletins - Sun Electric Corporation, Periodical
* Chiltons Auto Repair Manual - Chilton Book Co.
* Motors Auto Repair Manual - Motor, N.Y.

National Service Data - Mitchell Manuals, National Automotive Service, Box 10465, San Diago, California
The Automotive Electrical System - Barr-Flocco, Chilton Book Co., 1968
Automobile Power Accessories - Chilton Book Co., 1968
Automotive Mechanics - Crouse, McGraw-Hill Book Co., 1970
Automotive Engines - Crouse, McGraw-Hill Book Co., 1966
Automotive Fuel, Lubricating and Cooling Systems - Crouse, Mc-Graw-Hill Co., 1967

Training Aids:

Auto Mechanics, Catalog of Transparencies and Charts, Cept. of Defense Instructional Materials, N.W. Regional Educational Lab, Portland, Oregon
* Ford Service Publications, Box 7750, Detroit, Michigan
General Motors Film Library - General Motors Building, Detroit, Michigan
* Sealed Power Corp., Muskegon, Michigan
* Technical Training Bulletins (with slides), Marguette Corp.
* Lubrication Publications, Texaco, Inc., 135 E. 42nd Street, New York, N.Y.
* Delco Remy Training Charts, United Delco Co.
* Automotive Course, Sun Electric Corp.

* Indicates that this material is not in the Fort Benton School System - however, purchase is recommended.

CONSTRUCTION TRADES

GRADE TWELVE

ELECTRICAL THEORY AND INSTALLATION

I. Develop an insight into electrical trades.

A. The student will identify electrical occupational areas.
B. The student will list characteristics which are in demand when considered for employment (punctuality, cleanliness, cooperative attitude, loyalty, workmanship, ability to meet and deal with public, etc.).
C. The student will explain general skill areas where a proficiency is required in the electrical trades (e.g., use of hand and power tools, metering and measuring equipment, understanding of electrical theory, reasoning and problem solving ability, etc.).

II. Develop the concept of electrical energy.

A. The student will review the characteristics of atomic structure.
B. The student will explain the "electron theory" in its application to the flow of electrical energy.
C. The student will be able to explain the difference in atomic structure of atoms in conductors and nonconductors.

III. Develop the understanding of chemical energy as it is related to electrical energy.

A. The student will demonstrate his understanding of a simple cell indicating the direction of current flow.
B. The student will diagram the wave pattern of direct current.
C. The student will differentiate between the dry cell and storage cell, giving the general characteristics of each.

IV. Develop an understanding of magnets and their capacity to generate electrical currents.

A. The student will discuss the internal structural theory of magnets, their polar actions, magnetic induction.
B. The student will demonstrate the operation of an electromagnet and explain its difference from a permanent magnet.
C. The student will demonstrate the production of an electrical current with a galvanometer.
D. The student will discuss the concepts of a moving coil and moving magnet in the production of alternating current.
E. The student will identify the major parts of an AC and DC generator and discuss the difference in terms of current produced.

V. Develop the concept of electromotive force and its measurement.

A. The student will diagram an electrical circuit and identify its basic parts.
B. The student will discuss the electromotive force of current in a circuit and the unit of measurement (volt).
C. The student will demonstrate the proper use of a voltmeter and multimeter.
D. The student will be able to demonstrate the commonly used varieties of voltmeters in measuring AC outlet voltage.

VI. Develop the understanding of electrical current and electron flow.

A. The student will diagram the wave sine of alternating and direct current.
B. The student will correlate the amphere with the quantity of water moving through a pipe over a given time.
C. The student will be able to demonstrate an AC anmeter.
D. The student will explain the use of a shunt in charning the anmeter current range.

VII. Develop the understanding of circuit resistance and its effect on amperage and voltage.

A. The student will describe electrical resistance and the relationship of conductor size and composition of current flow.
B. The student will illustrate uses of resistance in putting electrical energy to work.
C. The student will discuss ways in which resistance causes loss of useable electrical energy.
D. The student will be able to describe the unit of measurement for resistance and demonstrate on AC ohmmeter.

VIII. Develop skills and understanding relating to conductors and insulators.

A. The student will be able to identify common conductors and insulating materials by name.
B. The student will be able to demonstrate the use of an American Standard Wire Gage.
C. The student will be able to discuss the conductor gage in relation to the National Electrical Code on current carrying capacity.
D. The student will be able to describe common uses of wire and sizes of wire recommended for those uses.
E. The student will demonstrate the use of a wire cutter/stripper or similar tool.
F. The student will be able to produce an acceptable pigtail splice, tee-tap splice, and western union splice and use proper techniques in soldering the connections.
G. The student will demonstrate the use of solderless connectors.

IX. Develop the ability to vary voitage, current and resistance factors and determine its effect upon a circuit.

A. The student will describe the relationship between voltage, current and resistance in a circuit.
B. The student will illustrate the term watt in a diagram showing the wattage in relation to electrical current and force.
C. The student will discuss the kilowatt and its use in measurement of electrical power consumption.
D. The student will demonstrate his ability to read a watt-hour meter accurately.

X. Develop an understanding of electrical transmission and entrance into the home.

A. The student will discuss the general principles of an alternating current generator.
B. The student will summarize the factors which cause line loss on transmission lines and the methods used to partially overcome line losses.

C. The student will be able to describe the purpose of transformers at electrical substations and on service poles.
D. The student will distinguish between primary and secondary coils on a transformer and differentiate between a step-up and step-down transformer.
E. The student will discuss the step-down transformer at the service pole and indicate the arrangement of 115 and 230 volt service lines from the pole to the consumer, including possible locations of the kilowatt-hour meter.

XII. Develop ability to analyze pertinent electrical codes in relation to wiring from the service lines (or service drop) through the building.

A. The student will be able to discuss electrical codes as they apply to local electrical contracting.
B. The student will be able to interpret these codes on an actual installation to determine if they have been met.

XIII. Develop understanding of protective measures for home electrical circuits.

A. The student will identify proper line attachment methods and describe the function of a drip loop.
B. The student will explain the function of the distribution panel as it relates to circuit protection, to include grounding of circuits.
C. The student will demonstrate his understanding of various types of circuit breaker devices, fuses, etc., by explaining the operation of each.
D. The student will identify types of conduit, armored cable, non-metallic sheather cable and indicate for what conditions each is recommended.

XIV. Develop competence at reading electrical wiring symbols.

A. The student will be able to identify USASU electrical wiring symbols as shown in chart form.
B. The student will translate an electrical plan for a building into a listing of fixtures and types of conductors needed.
C. The student will originate a floor plan to incorporate specific fixtures and arrangements given by the instructor.
D. The student will discuss electrical installations and the appropriate construction phase for this work.

XV. Develop skill at installation of circuit wiring.

A. The student will describe circuits from distribution panel, taking into consideration economy, load, function and special problems.
B. The student will be able to use available codes and reference information to determine proper conductor and to select the approved method of installation best suited for particular jobs.

XVI. Develop the ability to install common fixtures in approved manner.

A. The student will be able to demonstrate proper installation methods for attaching junction boxes to the building structure.
B. The student will be able to demonstrate proper splicing and insulating procedures.
C. The student will be able to install both flush mount and surface mount fixtures.

XVII. Develop awareness of sources of technical information pertinent to maintaining up-to-date information on electrical trade knowledge and skills.

A. The student will be able to identify the source of all electrical codes pertinent to residential and public facility electrical installations.
B. The student will be able to locate answers to practical problems in resource books available to the student.
C. The student will be able to cite examples of trade periodicals and current manufacturer publications which can be used to keep abreast of new methods and materials in the electrical trade.

Example of Behavioral Instructional Objective:

Every student will diagram a step-down transformer and label the primary and secondary coil and explain the function of this type of transformer (XI.D).

RESOURCES:

Books:

Text: Electrical Construction Wiring - American Technical Society, 848 E. 586h Street, Chicago, Ill. 60637

Sample Texts: Basic Electricity and Electronics - American Technical Society, 848 E. 58th Street, Chicago, 60637
Electrical Trades: Blueprint Reading - Delmar Publishers, Albany, N.Y.
Simplified Electrical Wiring - Sears-Roebuck, Minn., Minn.
National Electrical Code - National Fire Protection Assoc., 1968

GRADE TWELVE

PLUMBING SKILLS AND TRADE

I. Develop an understanding of plumbing and pipefitting trades.

   A. The student will be able to discuss types of skills and knowledge which are required in this trade area.
   B. The student will be able to describe sequence of training and apprenticeships necessary to enter the plumbing and pipefitting trade.

II. Develop the knowledge of general and special tools of the trade.

   A. The student will identify types of tools critical to the trade (e.g., wrenches, fitting tools, and threaders).
   B. The student will be able to demonstrate safe operating techniques of tools.

III. Develop an understanding of the types of piping utilized in the building industry.

   A. The student will be able to identify various types of pipe common to the plumbing trade.
   B. The student will be able to specify special uses and limitations of pipes.
   C. The student will be able to recommend materials for specific job specifications through familiarity with existing codes and standards.

IV. Develop understanding of techniques in cutting and fitting galvanized and black iron pipe.

   A. The student will demonstrate his ability to find O.D. and I.D. measurements and determine finish length of pipes fitted into various fittings.
   B. The student will cut ream and thread a length of pipe.
   C. The student will be able to select valve and fittings by name and complete assigned fitting exercises.

V. Develop skill in forming, cutting and connecting copper pipe.

   A. The student will use proper procedures in forming copper tubing to meet space requirements.
   B. The student will be able to demonstrate ability of cutting and attaching connectors to copper pipe.

VI. Develop understanding and methods of installing plastic pipe materials.

   A. The student will describe limitations and advantages of plastic pipe.
   B. The student will be able to discuss proper fitting, cutting and connecting techniques.

VII. Develop understanding and methods of installing cast-iron pipe.

   A. The student will discuss cast iron pipe as used in water mains and sewage lines.
   B. The student will describe the cutting of cast pipe with pipe cutter, hack saw and cold chisel.

VIII. Develop an understanding of drains, and related waste disposal systems.

A. The student will be able to describe the drain system for facilities which utilize a septic tank and drain field.
B. The student will be able to describe materials and connections of a drain system which utilizes a municipal sewage system.
C. The student will discuss the packing, leading and caulking of cast-iron pipe.
D. The student will identify a variety of fittings and traps for waste systems.

IX. Develop practical skill in general plumbing tasks.

A. The student will be able to determine the plumbing needs for specific household fixtures.
B. The student will install and plumb a fixture as a class project.
C. The student will explain maintenance procedures (e.g., replacing faucet washers, adjusting flush tank float, replacing flush tank float, replacing flush tank discharge valve, removing stoppages from drain pipes, etc.).

Example of Behavioral Instructional Objective:

Each student will perform the cutting, reaming, and threading operations on galvanized pipe, producing a satisfactory end product as judged by the student and instructor (IV.B).

RESOURCES:

Books:

Text: How to Design and Install Plumbing - American Technical Society, 848 E. 58th Street, Chicaco, Ill. 60637, 1960

Sample Texts: The Farm Shop - MacMillan Co.
Plumbing Trades: Blueprint Reading and Sketching - Delmar Publishers, Albany, N.Y.

GRADE TWELVE

CARPENTRY AND BUILDING CONSTRUCTION

I. Review basic skills with hand tools.

A. The student will demonstrate his ability to identify basic hand tools by their proper name and function.
B. The student will demonstrate the use of common hand tools.
C. The student will demonstrate proper care and maintenance of hand tools.

II. Review basic skills with power tools.

A. The student will identify basic power tools and explain their function.
B. The student will demonstrate safe and acceptable skills operating power tools.
C. The student will demonstrate the proper care and maintenance of power tools.

III. Develop familiarity with tools for leveling and site location.

A. The student will demonstrate his ability to set up, use and store equipment properly.
B. The student will be able to specify elevations and boundary locations in the field and on blueprints.

IV. Develop an understanding of carpentry as a career.

A. The student will discuss carpentry career opportunities.
B. The student will be able to discuss training and apprenticeship requirements in carpentry.
C. The student will be able to list personal characteristics and qualifications which increase chances for job success.

V. Develop an appreciation for construction safety.

A. The student will report where dangers can be expected and specify necessary precautions.
B. The use of mature behavior patterns will be demonstrated by each student.

VI. Develop an understanding of classifications and uses of building materials.

A. The student will be able to identify grades, dimensions and kinds of common wood products.
B. The student will demonstrate his knowledge of metal, concrete and masonry products.
C. The student will demonstrate his knowledge of various other natural and synthetic building materials (e.g., fiber board, asphalt, plastics, etc.)
D. The student will be able to discuss glueing and fastening materials.

VII. Develop an understanding of blueprints, specifications and codes.

A. The student will specify the meanings of blueprint contents, symbols and scales and be able to construct simple original plans.
B. The student will be able to summarize the importance of building specifications.
C. The student will be able to compare and translate city building codes, standards and permit regulations.

VIII. Develop an appreciation of planning for installation of utilities, heating and ventilation systems.

A. The student will indicate the necessity of early planning for the inclusion of utilities and special systems in construction.
B. The student will be able to diagram a utility system on a floor plan

IX. Develop site location skills.

A. The student will be able to establish points within property boundaries for the location of a building.
B. The student will be able to discuss the factors of wind, solar radiation, view and activity with site location.
C. The student will be able to describe the economic factors relative to utility location and service relative to building site.

X. Develop an understanding of footings and foundations.

A. The student will demonstrate his ability to establish building lines and erect batter boards.
B. The student will illustrate footing and foundation design.
C. The student will be able to construct forms for footing and foundation.
D. The student will be able to describe concrete production and other construction methods for building a foundation.

XI. Develop an understanding of floor planning and sub-floor construction.

A. The student will identify types of framing commonly used in building construction.
B. The student will recite names and functions of various sub-floor components.
C. The student will be able to demonstrate skill in sub-floor construction.

XII. Develop a familiarity with scaffolds and ladders.

A. The student will be able to erect scaffolding which will be solid and square.
B. The student will be able to construct a safe ladder.
C. The student will be able to select proper ladder or scaffold for various building construction tasks.

XIII. Develop the ability to construct wall and ceiling framing.

A. The student will name the wall and ceiling frame parts.
B. The student will be able to erect frames using correct materials and proper nailing techniques.

XIV. Develop the ability to construct roofs and roof framing.

A. The student will discuss factors involved in roof type selection.
B. The student will be able to diagram roof frame parts and label parts.
C. The student will demonstrate the use of a framing square in rafter construction.
D. The student will discuss types of roofing materials.
E. The student will be able to construct flashings and other roof finishing operations.

XV. Develop the ability to construct and install windows and exterior doors.

A. The student will be able to install various types of window arrangements.
B. The student will be able to discuss the parts in a sectional view of window detail.
C. The student will be able to exhibit proficiency in installing commercially prepared windows.
D. The student will be able to install an assembled door frame and hang the door.
E. The student will discuss the proper installation of locks and door hardware on exterior doors.

XVI. Develop knowledge of types of fabrication of exterior wall finishes.

A. The student will identify the cornice, soffit and rake on a diagram.
B. The student will be able to list common types of exterior wall finish materials.
C. The student will be able to install siding materials.

XVII. Develop an understanding of proper construction of chimney and fireplaces.

A. The student will discuss types of fireplaces and common chimney arrangements.
B. The student will be able to describe general procedures in installing chimneys and fireplaces.

XVIII. Develop an understanding of the function and installation of thermal and sound insulation.

A. The student will specify the stage of construction where the insulation should be installed.
B. The student will discuss the basic concepts of heat transfer as it applies to building construction.
C. The student will be able to identify types of thermal insulating products.
D. The student will be able to discuss principles of sound insulation and relate this understanding to construction materials.

XIX. Develop the ability to select and install interior wall and ceiling finishes.

A. The student will be able to describe techniques of fitting, fastening and finishing of interior wall and ceiling materials.
B. The student will be able to construct a wall using proper procedures for two basic wall finishes.

XX. Develop knowledge and skill in installing finish flooring.

A. The student will list common types of wood flooring.
B. The student will discuss the function of underlayment.
C. The student will describe methods of applying adhesive and laying of asphalt or acrylic tile.

XXI. Develop the ability to complete simple stair construction.

A. The student will demonstrate the laying out of a stair stringer using a framing square.
B. The student will identify tread and riser and will indicate methods of stair trim and finish.

XXII. Develop skill in erecting interior frames and doors and fitting interior trim.

A. The student will be able to demonstrate door framing on inner walls.
B. The student will be able to describe door sizes and grades.
C. The student will be able to discuss moldings and interior trim.
D. The student will be able to demonstrate his ability to install interior door hardware.

XXIII. Develop a general understanding of post-and-beam construction.

A. The student will be able to summarize general characteristics of post-and-beam construction as it differs from other framing techniques.
B. The student will be able to discuss special uses and effects possible with post-and-beam construction.

Example of Behavioral Instructional Objective:

From a diagram furnished by the instructor, each student will identify numbered parts of wall and ceiling framing and write these names with at least 90% accuracy (XII.A).

RESOURCES:

Books:

Text: Modern Carpentry - Goodheart-Wilcox, South Holland, Ill., 1969

Sample Texts: Carpentry Trades: Blueprint Reading and Sketching - Delmar Publishers, Albany, N.Y., 1957
Electrical Trades: Blueprint Reading - Delmar Publishers, Albany, N.Y., 1969
Plumbing: Blueprint Reading and Sketching - Delmar Publishers, Albany, N.Y., 1968
Woodworking for Industry - Charles A. Bennett Co., Peoria, Ill. 61614, 1963
Cabinetmaking and Millwork - Charles A. Bennett Co., Peoria, Ill. 61614, 1967
Architecture - McKnight & McKnight, Towarda Ave. & Route 66, Bloomington, Ill. 61701, 1967

METAL TRADES

GRADE ELEVEN

SHEET METAL PROJECT DESIGN AND CONSTRUCTION

I. Develop appreciation for sheet metal work as a useful skill as well as a career opportunity.

   A. The student will describe types of items constructed of sheet metals.
   B. The student will identify occupational titles which incorporate sheet metal work and determine job opportunities and salary rates (e.g., welder, bodyman, etc.).
   C. The student will discuss types of skills, attitudes and behaviors which are essential to a career in sheet metal industries.

II. Develop understanding of sheet metal, its definition and composition.

   A. The student will be able to identify sheet metal (e.g., galvinized, tinplate), sheet copper, sheet brass, and sheet aluminum.
   B. The student will specify the gauge limits of sheet metal.
   C. The student will be able to discuss the use of alloys in relation to special properties desired in sheet metals.

III. Develop the ability to construct and interpret layout information.

   A. The student will be able to apply scale, dimensions and new orientation to reading layouts.
   B. The student will be able to construct a stretchout of a project using a layout of horizontal and perpendicular lines.
   C. The student will be able to construct a paper stretchout of a project which includes both oblique and curved lines using squares to establish the curve.
   D. The student will produce a pattern of an object.

IV. Develop an awareness of hazards in using sheet metal, the tools and machines involved, and other equipment found in a sheet metal shop.

   A. The student will be able to list precautions necessary for safe handling of metals and operating of tools and machinery.
   B. The student will be able to demonstrate First Aid and fire safety procedures.

V. Develop the ability to safely and accurately cut sheet metal.

   A. The student will identify basic hand and power tools for cutting sheet metal.
   B. The student, using a pattern, will scribe the project outline and use the proper cutting snips to produce the product.
   C. The student will exhibit his capacity to use all types of snips and safely perform the operations of a squaring sheer.

VI. Develop an understanding, and the ability to determine, the proper use of rivets in sheet metal.

   A. The student will discuss the use of rivets in projects.
   B. The student will demonstrate punching, drilling, and the installation of rivets in sheet metal.
   C. The student will demonstrate the proper method of removing rivets from sheet metal.

VII. Develop the ability to select proper folding tools and perform the operations.

A. The student will demonstrate the use of a bench plate and forming stake.
B. The student will demonstrate the bending of sheet metal using "C" clamps and wood blocks.

VIII. Develop the ability to select proper seams and edges for sheet metal projects.

A. The student will identify a variety of seams and describe the general use of each (e.g., single, double, lap, etc.).
B. The student will explain the methods used to form a wired edge and give its advantages over a hemmed edge.

IX. Develcp the skills and understanding needed to select and construct proper sheet metal seams.

A. The student will construct a sheet metal project using hemmed edges and lapped corner joints with clamps and wood blocks.
B. The student will diagram the "S" and drive clips used in joining duct sections.
C. The student will demonstrate the proper use of a brake.
D. The student will construct common seams on the brake.
E. The student will construct a dovetail seam on a sheet metal pipe attaching it to a plate flange.

X. Develop an understanding of the forming rolls.

A. The student will discuss the operations of the forming machine.
B. The student will be able to construct a sleeve.

XI. Develop an understanding of the crimper beader and other shaping tools.

A. The student will describe the use of the crimped edge in round sheet metal pipe.
B. The student will discuss the use of a bead pattern for functional and decorative use.
C. The student will be able to operate the crimper and beader.
D. The student will be able to identify uses for turning, burring and raising of sheet metal.

XII. Develop an understanding of types of solder, soldering fluxes and soldering equipment.

A. The student will describe the alloy used in "soft solder" and relate the percentages of tin and lead to the melting point of the solder.
B. The student will identify soldering fluxes and relate them to their function.
C. The student will identify the various types of soldering coppers (irons) and discuss the shapes and sizes of soldering heads as they affect the soldering task.
D. The student will demonstrate the shaping and tinning operations on a soldering copper and be able to demonstrate the use of solammoniac solution in keeping the copper clean.
E. The student will demonstrate the use of the electric soldering copper and the torch and furnace operation required for plain copper heating.

XIII. Develop the ability to manipulate the soldering copper.

A. The student will discuss the function of the copper and its positioning to perform these functions (1. heat metal to the solder melting point; 2. melt solder and keep it molten.).
B. The student will demonstrate methods of preparing metal for joining, applying flux, and completing a soldered joint.
C. The student will prepare and properly complete a sweat seam and a sweat patch.

XIV. Develop a competence in sheet metal project construction.

A. The student will demonstrate procedures related to sheet metal construction.
B. The student will construct and notch a pattern directly on sheet metal.
C. The student will apply sheet metal skills to project construction.

Example of Behavioral Instructional Objective:

Using paper provided, each student will construct a stretchout of a sheet metal project given by the instructor with an allowable tolerance of 2^{o} on an angle and 1/8 inch on any dimension (III.B).

RESOURCES:

Books:

Text: Sheet Metal Shop Practice - American Technical Society, Chicago, Ill.

* Sample Text: General Shop Metalwork - McKnight & McKnight Publishing Co., Towardy Ave. and Route 66, Bloomington, Ill., 1947

* Metalwork Technology and Practice - McKnight & McKnight Publishing Co., 1955
* Sheet Metal Drafting Books I and II - International Textbook Co., Scranton, Penn.
* Developments and Layout Problems - International Textbook Co., Scranton, Penn.
* Hand Processes - Delmar Publishers, Inc., Albany, N.Y.
* Machine Processes - Delmar Publishers, Inc., Albany, N.Y.
* Measurement and Layout - Delmar Publishers, Inc., Albany, N.Y.
* Sheet Metal Principles and Procedures - Prentice Hall, Inc., Englewood Cliffs, N.J., 1953
* Sheet Metal Work - McKnight & McKnight Publishing Co., 1961

* Indicates that this material is not in the Fort Benton School Systems - however, purchase is recommended.

GRADE TWELVE

FOUNDRY SKILLS AND PRACTICE

I. Develop an appreciation and understanding of foundry.

A. The student will be able to discuss foundrying as a skill used in industry and hobbies.
B. The student will describe skills and knowledge required of the foundryman to gain proficiency.
C. The student will be able to discuss craftsmanship as it applies to foundry products.
D. The student will be able to indicate the occupational requirements of a foundryman.

II. Develop an understanding of safe practices in the foundry shop.

A. The student will demonstrate safe conduct at all times.
B. The student will demonstrate the proper and safe utilization of all foundry tools and equipment.
C. The student will exhibit a knowledge of steps to be taken in case of an emergency or accident.

III. Develop an understanding of molding.

A. The student will be able to indicate why the mold is necessary in foundry.
B. The student will be able to discuss types of molds and how they are formed.
C. The student will be able to explain how patterns are made using various materials (e.g., wood, metal, wax, and plaster).
D. The student will be able to differentiate the uses of the split patterns and solid patterns.

IV. Develop an understanding of pattern function and design.

A. The student will be able to define positive, negative and zero draft.
B. The student will be able to discuss how draft will affect the mold.
C. The student will be able to explain how draft will affect the design of the pattern.
D. The student will be able to calculate the shrink of various metals.

V. Develop an understanding of different types of molds.

A. The student will be able to differentiate between sand molds, metal molds, and other special molds.
B. The student will be able to explain how clay and sand are mixed to make a green sand mold.
C. The student will be able to discuss the uses of permanent, die, investment (lost wax), and plaster molds.
D. The student will be able to make a green sand mold.

VI. Develop an understanding of the equipment used for making molds.

A. The student will be able to name and explain uses of mold making tools (e.g., glask, cape, drag, molding board, riddle, rammer, strike bar, slick and spoon, trowel, lifter price pin, riser and draw pin, etc.).

B. The student will be able to properly handle and care for the foundry tools.

VII. Develop an understanding of the nomenclature and terminology in molding.

A. The student will be able to define molding terms (e.g., tempering the mold, parting compound, blowholes, vent holes, gate, core, etc.).

VIII. Develop an understanding of casting and its processes.

A. The student will be able to define casting.
B. The student will be able to discuss the different types of furnaces.
C. The student will be able to list the protective clothing required for casting (e.g., cap, goggles, leather or asbestos apron and gloves, etc.).
D. The student will be able to name and discuss various casting tools and equipment (e.g., pyrometer, slagging bar, ladle, crucible, tongs, etc.).
E. The student will be able to locate the temperatures required for pouring metal.
F. The student will be able to discuss procedures in metal preparation using various common metals (e.g., lead, tin, zinc, copper, brass and iron, etc.).
G. The student will be able to demonstrate his knowledge of casting by completing a preassigned project.

Example of Behavioral Instructional Objective:

With a sketch provided, each student will identify examples of positive, negative and zero draft in patterns with 100% accuracy.

RESOURCES:

Books:

Text: Exploring Patternmaking and Foundry - Fan Nostrand Co., Inc., 120 Alexander Street, Princeton, N.J.

Sample Texts: Foundry Practices - American Technical Society, 848 E. 58th Street, Chicago, Ill. 60637
* Metalwork Technology and Practice - McKnight & McKnight, Towarda Ave and Route 66, Bloomington, Ill. 61701
* An Elementary Foundry Manual - McEnglevan Heat Treating and Manufacturing Co., Danville, Ill.

* Indicates that this material is not in the Fort Benton School System - however, purchase is recommended.

GRADE TWELVE

METAL FABRICATION

I. Develop an awareness of production welding as an industry.

A. The student will be able to discuss production techniques as used in the welding industry.
B. The student will be able to outline catagories within production welding.
C. The student will be able to list the skills required by a production welder.

II. Develop the ability to analyze the layout structurally sound frames and support systems.

A. The student will be able to discuss bending stress and resistance of fabrication materials.
B. The student will be able to diagram support frames to meet problem situations.
C. The student will be able to identify proper joints and bracing systems for angular and curve reinforcement.
D. The student will be able to discuss dimensions of structural material relative to support capacity and stress limits.

III. Develop a competence in basic fabrication skills.

A. The student will be able to discuss preplanning of projects and the use of sketches to establish sound structural and functional design.
B. The student will be able to demonstrate his ability to prepare a project plan using approved design techniques and drafting symbols.
C. The student will be able to demonstrate his ability to lay out, cut, drill, shape and fasten metal parts using no heat-operated devices.
D. The student will be able to identify common types and other non-thermal connectors.
E. The student will be able to prepare metal stock (cutting, shaping, forming holes, and attaching) using welding equipment.
F. The student will be able to weld joints in metal stock of varying thickness and composition (e.g., sheet metal to iron).

IV. Develop a competence in fabrication through project construction.

A. The student will fabricate or assist in the fabrication of an approved project.
B. The student will be able to demonstrate his ability to function in a production welder capacity.

V. Develop specialized skills in metal fabrication as required.

A. The student will be able, using reference materials available, to demonstrate new skills after reviewing his findings with the instructor and receiving permission to proceed.
B. The student will be able to approach fabrication problems with confidence in his ability to find solutions or alternate methods satisfactory to successful project completion.

Example of Behavioral Instructional Objective:

Given a problem situation in pipe construction, including stress demands, each student will draw an isometric view of his solution showing materials and dimensions. All symbols and techniques used in the drawing will conform to standards established by the instructor.

RESOURCES:

Books:

Text: Modern Welding - Goodheart-Wilcox Co., South Holland, Ill., 1970

Sample Texts: * Technical Metals - Charles A. Bennett Co., Inc., Peoria, Ill. 61614, 1968
* Welding Technology - American Technical Society, 848 E. 58th Street, Chicago, Ill. 60637, 1968

* Metal Projects: Books I & II - Goodheart-Wilcox Co., Inc., S. Holland, Ill., 1966

* Indicates that this material is not in the Fort Benton School Systems - however, purchase is recommended.

REVISION

The Vo-Tech Curriculum was derived to create an organized pattern for the learning development of our students. As in any aspect of life, change is inevitable; therefore, we must constantly evaluate and revise this guide. The following evaluation instrument is to be completed by each teacher involved with this curriculum near the end of each semester.

EVALUATIVE INSTRUMENT

1. Are the themes indicated in this curriculum meaningful and relevant? If so, how? It not, why not?

2. Do the major concepts help develop the theme at that level? If so, how? If not, why?

3. Are the behavioral sub-concepts helpful in developing the main concepts? If not, list those that need revision.

4. Are the concepts suited to the level and abilities of the students? If not, what do you suggest?

5. Are there any concepts that should be omitted? If so, which ones and why?

6. In your opinion are there any concepts that could and should be added? If so, why?

7. Is the content of the theme too great to be covered in the alotted time? If so, what would you delete?

8. Please list any new materials and ideas you have found helpful in your efforts to teach the concepts indicated.

9. Indicate those teaching approaches that you are using and list any others that you find useful.

10. What is your opinion of the total curriculum? Please explain.

APPENDIX A

SURVEYING FORT BENTON'S TRADES AND INDUSTRIES EFFORTS

Those staff members responsible for any portion of the Trades and Industry program were asked to respond to the attached survey instrument. The instrument is short and is composed of three parts. Each instructor was to indicate (1) the nature of the T & I offerings at their level of instruction; (2) what the instructor considered the strengths of that offering; and (3) what the instructor considered the weaknesses of that offering.

The feedback obtained from this instrument is summarized as follows:

1. Fort Benton's past areas of emphasis were:

   Grades 11-12 - Small Engines, Building Trades, and Welding

2. Strengths:

   a) Students were involved with the planning, organizing and designing of the entire T & I program.
   b) Lab-Coop Instructor program has generated new interest and enthusiasm as well as presenting the practical side of certain types of employment.
   c) Students were actually involved with the construction of a project (the T & I shop).

3. Weaknesses:

   a) Over-all lack of time for organization.
   b) Facilities originally were overcrowded.
   c) Student scheduling was inadequate for the program.

SCHOOL SYSTEM SELF SURVEY

This survey is being distributed to those members of our staff responsible for any portion of our Vo-Tech program - Commercial - Each teacher is asked to reply to all the statements.
Industrial Arts
Vo-Ag
Home Ec.
T & I

Teacher's Name_____

Teacher's Grade Level_____

I. What is the Nature of the Vo-Tech Offering presently at your grade level? (i.e., what themes, concepts, ideas, etc., do you teach with reference to Vo-Tech during the course of the year?)

a) Major Themes or Topics_____

_____

_____

_____

_____

b) Units_____

_____

_____

_____

c) Concepts_____

_____

_____

_____

d) Others_____

_____

_____

_____

Comments:

II. What do you consider to be the strengths of this offering?

III. What do you consider to be the weaknesses of this offering?

APPENDIX B

CURRICULUM DEVELOPMENT SURVEY

Various college professors, learning laboratory representatives and State Department representatives were asked to respond to the attached instrument. The purpose was to obtain informative date in the English (Language Arts), Math, Science and Vo-Tech Curriculum areas. The instrument was designed to consider two major areas: (1) General information concerning the individual and agency that individual represented and (2) Specific curriculum information.

Thirty-one questionnaires were distributed; fourteen were returned. The following is an attempt to summarize the information.

It appears as if very few schools in the state are known to be developing curriculum guides at this time. Even though it was felt that many schools are beginning to do "something" in the realm of curriculum, the survey respondents did not for the most part indicate recommended places to visit. Of the programs and schools mentioned as doing "something" in curriculum, it appeared that all had a tendency to be striving toward some form of individualization in those curriculum areas they were concentrating on.

CURRICULUM DEVELOPMENT

This survey instrument is being circulated among college professors, learning laboratory representatives and State Department representatives. The purpose is to obtain informative data in the English (Language Arts), Math, Science, and Vo-Tech Curriculum areas. Your reply to this instrument will be greatly appreciated. Results will be sent to you upon request. A return self-addressed envelope has been enclosed for your convenience.

I. GENERAL INFORMATION

1. Name of Institution or Agency you represent_____

2. Describe the lines of communication you have with the local school districts in regard to curriculum development.

3. How many schools do you personally contact during the course of the year concerning curriculum development and improvement?

4. What is basically the area of concentration that you become involved with in your work with local school districts?

II. SPECIFIC CURRICULUM AREAS

1. Are you aware of any school districts that have developed or are in the process of developing curriculum guides or outlines in the areas of Language Arts, Math, Science and Vo-Tech? (If yes, please indicate)

2. Are there any school districts you would recommend a visitation to concerning their curriculum development? (If yes, please indicate where)

3. Are you aware of any worthwhile and interesting "new" happenings in the area of Language Arts - K-12? (If so, please relate)

4. Are you aware of any worthwhile and interesting "new" happenings in the area of Math - K-12? (Please relate)

5. Are you aware of any worthwhile "new" and interesting happenings in the area of Science - K-12? (Please relate)

6. Are you aware of any worthwhile "new" and interesting happenings in the area of Vo-Tech (Home Ec., Industrial Arts, Trades and Industry, Commercial, Vocational-Agricultural) (Please relate)

7. Do you have any lists of reference materials that you would share with us concerning any of these curriculum areas? (If so, please enclose list and return with questionnaire.)

APPENDIX C

Reference Material

The following reference material was used to make this curriculum complete and accurate. Each area could be developed further using these resources. Other sources listed under Sample Texts in the resource sections of this curriculum will also add to the scope of the courses included.

1. Alerich, Walter N., Electrical Construction Wiring, American Technical Society, 848 E. 58th Street, Chicago, Ill. 60637, pp. 476.

2. Bruce, Leroy F., Meyer, Leo A., Sheet Metal Shop Practice, American Technical Society, 848 E. 58th Street, Chicago, Ill. 60637, pp. 296.

3. D'Arcangelo, Barthlomew, et al, Blueprint Reading and Sketching: Plumbing Trades, Delmar Publishers, Inc., Albany, N.Y. 12205, pp. 119.

4. Feirer, John L., Tatro, Earl E., Machine Tool Metalworking, McGraw-Hill Book Co., Chicago, Ill., pp. 446.

5. Glenn, Harold T., Automechanics, Charles A. Bennett Co., Peoria, Ill. 61614, pp. 544.

6. Ludwig, Oswald A., McCarthy, Willard J., Metalwork: Technology and Practice, McKnight & McKnight Publishing Co., Bloomington, Ill., pp. 630.

7. Tux, Donald G., Ray, Willis E., The World of Construction, McKnight & McKnight Publishing Co., Bloomington Ill., pp. 560.

8. McDonnell, Leo P., Blueprint Reading and Sketching: Carpentry Trades, Residential, Delmar Publishers, Albany, N.Y. 12205, pp. 200.

9. Matthias, A. J., Jr., Smith, Esles, Sr., How to Design and Install Plumbing, American Technical Society, 848 E. 58th Street, Chicago, Ill. 60637, pp. 446.

10. Miner, Harvey D., Miller, John G., Exploring Patternmaking and Foundry, D. Van Nostrand Company, Princeton, N.Y., pp. 206.

11. Mullin, Ray C., Electrical Trades: Blueprint Reading, Delmar Publishers, Inc., Albany, N.Y. 12204, pp. 290.

12. Pipe, Ted, Small Engine Gasoline Engines: Training Manual, Howard W. Soms & Co., Indianapolis, Inc., 46206, pp. 223.

13. Rusinoff, S. E., Foundry Practices, American Technical Society, 848 E. 58th Street, Chicago, Ill. 60637, pp. 261.

14. Stephenson, George E., Small Gasoline Engines, Delmar Publishers, Inc., Albany, N.Y. 12204, pp. 165.

15. Wagner, Willis H., Modern Carpentry, Goodheart-Wilcox Co., New Holland, Ill. 60637, pp. 480.